

EXPANDED
PROGRAMME
ON IMMUNIZATION



Missed opportunities for immunization

Review of studies from developing and
industrialized countries

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Contributions from the Rockefeller Foundation and the United Nations Development Programme to the WHO Expanded Programme on Immunization were used to fund the development and testing of the missed opportunities survey method.

Many immunization staff in the field tested this method, often under difficult conditions.

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EXECUTIVE SUMMARY

Since 1983 the EPI Global Advisory Group has recommended that programme managers seek ways to reduce missed opportunities for immunization. Protocols for the assessment of missed opportunities were developed by EPI and widely distributed. Today, considerable information exists on the magnitude and the reasons for missed opportunities for immunization in developing and industrialized countries. This paper reviews studies on missed opportunities published in the world literature or reported to WHO as of July 1991. It includes studies that defined a missed opportunity as any contact with a health service that did not result in an eligible child or woman receiving all needed vaccines. Studies were classified as population-based surveys, health-service based surveys, or intervention trials. A standard measure of the prevalence of missed opportunities was calculated for each study.

Seventy-nine studies were identified from 49 countries; 59 studies were conducted in developing countries and 20 studies in industrialized countries. Of the 79 studies, 52 (66%) were health service-based surveys, 18 (23%) were population-based surveys, and nine were intervention trials. Missed opportunities were found in all but one of the 79 studies. A median of 32% (range, 0%-99%) of the children and women of childbearing age who were surveyed had missed opportunities for immunization during visits for immunization or other health services. Among 19 studies which assessed missed opportunities for both women and children, the majority found that missed opportunities for women were several-fold higher than for children. These data reflect the lower coverage with tetanus toxoid (39%) among women as compared with global coverage of 80% or more for the six EPI antigens among children by their first birthday.

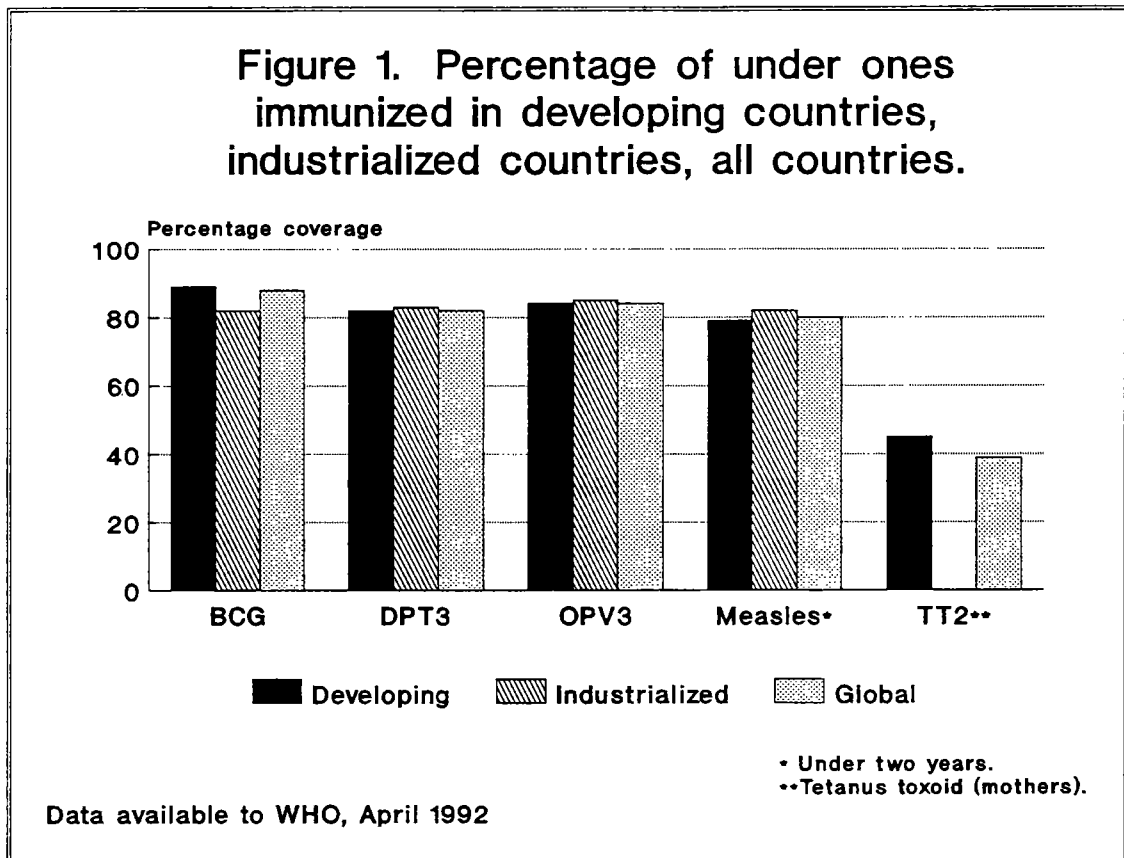
The most important reasons for missed opportunities were (1) the failure to administer simultaneously all vaccines for which a child was eligible (median prevalence 22%); (2) false contraindications to immunization (median prevalence 19%); (3) health worker practices including not opening a multidose vaccine vial for a small number of persons to avoid vaccine wastage (median prevalence 16%); and (4) logistical problems, such as vaccine shortages, poor clinic organization, and inefficient clinic scheduling (median prevalence 10%). Refusals by patients or their families were infrequent (median prevalence 3%).

Based on the reasons identified in this global review, the following recommendations are relevant for immunization programmes in all countries: (1) use missed opportunity surveys to routinely monitor immunization programmes; (2) screen and immunize all children and women of childbearing age at every health care contact; (3) administer vaccines simultaneously; (4) emphasize true contraindications to health workers; (5) provide educational updates on immunization policy to health workers; and (6) reduce vaccine wastage by choosing the correct size of vials.

1. INTRODUCTION

A worldwide revolution in immunization programme development has occurred since the inception of the Expanded Programme on Immunization (EPI) in 1974 (1). Immunization coverage levels in developing and industrialized countries are now similar (Figure 1). Based on information reported to the World Health Organization (WHO) as of April 1992, global immunization coverage for children by their first birthday was 88% for BCG vaccine, 82% for three doses of DPT vaccine, 84% for three doses of polio vaccine, and 80% for measles vaccine. However, for pregnant women in developing countries, coverage was only 43% for two doses of tetanus toxoid (2). With these coverage levels, WHO estimates that in 1991 immunization prevented some 3 million deaths from measles, neonatal tetanus and pertussis, and some 450 000 cases of paralytic poliomyelitis in developing countries (2). Additional efforts will be necessary to sustain this progress and to achieve the year 2000 goal of fully immunizing 90% of the world's children by their first birthday. Perhaps the greatest challenge will be to raise the tetanus toxoid coverage of women to the same levels seen for children.

A direct approach to increasing immunization coverage is to provide immunization to all eligible persons at every opportunity. The strategy of immunizing at every opportunity has been recommended by the EPI Global Advisory Group (GAG) since 1983 (3,4). Immunizations should be offered at every contact point, including preventive and curative



health services. Countries should review national immunization policy and remove excessive contraindications. Children suffering from malnutrition and minor illness are at particular risk for vaccine-preventable diseases and should be immunized.

An opportunity for immunization is missed when a person who is eligible for immunization and who has no contraindication to immunization visits a health service and does not receive all the needed vaccines.

Missed opportunities for immunization occur in two major settings: (1) during visits for immunization and other preventive services (e.g., growth monitoring, nutrition assessments and oral rehydration training sessions) and (2) during visits for curative services. In both settings, eliminating missed opportunities has the potential to raise overall immunization coverage in a population, particularly when the availability and use of health services is high. When the availability and use of health services is low, immunizing at every health care contact is extremely important because the risk for vaccine-preventable diseases is likely to be high in these areas.

In 1987, when results from several surveys in developing countries indicated that the majority of children attending curative care facilities were missing opportunities to be immunized, the GAG called for more surveys to investigate the magnitude of the problem for children and women of childbearing age and to identify strategies to reduce missed opportunities (5). EPI developed standard protocols for studying missed opportunities in 1984 and 1988 (6,7). Results of selected studies on missed opportunities in developing countries were summarized in 1987 and 1989 (8,9).

This paper reviews the studies on missed opportunities from developing and industrialized countries that were in the published literature or reported to WHO as of July 1991. The paper provides information on the global magnitude of missed opportunities, the demographic differences in missed opportunities, and the reasons for failure to immunize during health visits. Recommendations are made on strategies to reduce missed opportunities, emphasizing the usefulness of periodic systematic monitoring to evaluate the quality of immunization programme performance at the health service level and to monitor progress toward reducing missed opportunities.

2. METHODS

2.1 Criteria for inclusion of studies in the review

This review includes studies that assessed on missed opportunities for immunization in the EPI target groups, children and women of childbearing age. We reviewed studies reported in the world literature on missed opportunities for immunization or failure to vaccinate and unpublished studies reported to WHO as of July 1991. The review

considered only the studies that defined a missed opportunity for immunization as any contact with a health service that did not result in an eligible child or woman receiving all the needed vaccines. Studies that assessed the reasons why children and women were not fully immunized or up-to-date but that did not link the reasons to a health service contact were excluded.

2.2 Classification by study design

Studies on missed opportunities for immunization were classified in two groups: (1) observational surveys and (2) intervention trials.

Observational surveys measure missed opportunities through review of immunization or medical records or interviews with patients, parents or providers. Observational surveys measure the magnitude and the importance of reasons for missed opportunities. They were further classified by the method used to select study participants as (a) population-based surveys and (b) health service-based surveys. The ideal study design for measuring missed opportunities is a representative population-based survey because it can define the potential gain in immunization coverage achievable in a total population through eliminating missed opportunities. In practice, however, this approach is difficult and expensive and health service-based surveys are more likely to be conducted.

Intervention trials measure the change in missed opportunities and/or immunization coverage before and after instituting an intervention to reduce missed opportunities. Intervention trials were further classified as (a) controlled trials with a comparison group in which no intervention was introduced during the study period; and (b) trials with historical controls that compared the occurrence of missed opportunities before the intervention to the occurrence in the same group after the intervention. The ideal intervention trial is the controlled trial; however, these studies are difficult to conduct. Moreover, because the occurrence of missed opportunities often signals managerial problems, health facilities where they are identified are likely not to wait until interventions are tested before implementing strategies to reduce missed opportunities. Therefore, most intervention trials used historical controls.

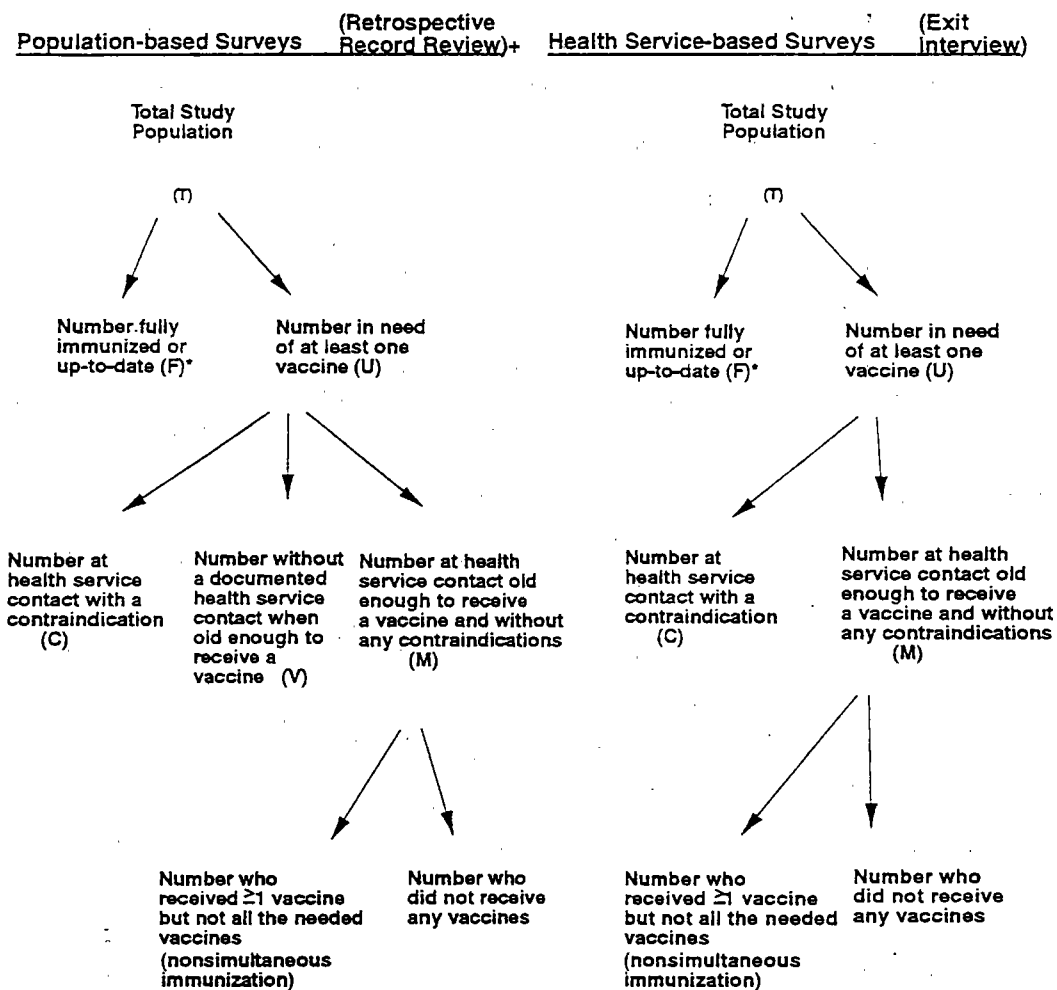
2.3 Calculating the prevalence of missed opportunities

We calculated a standard summary statistic for the prevalence of missed opportunities for each study. When insufficient data were available in the study report, the authors were consulted for additional information needed to calculate the summary statistic.

The prevalence of missed opportunities was calculated as the number of persons without a true contraindication to immunization who completed a health care visit and remained not fully immunized or up-to-date for age according to the national immunization policy, divided by the total number in the study population.

The method used to calculate the prevalence of missed opportunities is shown in Figure 2. The total study population (T) was divided in two groups: those who were fully immunized or up-to-date for immunization for their age (F); and those who were not (U). These groups were based on the national immunization schedule in the country where the study was conducted. The number of children or women who missed at least one opportunity for immunization (M) was calculated by subtracting from U the number who had a true contraindication to immunization (C) and the number who were too young to be immunized (V). V was relevant only in population-based surveys or surveys where immunization cards or medical records were reviewed retrospectively.

Figure 2. Method of calculating missed opportunities.



+ Includes health service-based surveys that conducted retrospective record reviews.

* Up-to-date for age was based on the immunization policy of individual countries.

The following equation was used to calculate the standard estimate of the prevalence of missed opportunities:

$$P1 = (U - V - C / F + U) \times 100, \text{ or}$$
$$P1 = (M / T) \times 100$$

where P1 is the prevalence of persons in the study population who had at least one missed opportunity.

2.4 Calculating the inefficiency of health services

We also calculated the prevalence of missed opportunities for persons needing an immunization during the health visit. This statistic measures the inefficiency of the health service in immunizing eligible children and women. It is calculated by the following equation:

$$P2 = (U - V - C / U - V) \times 100, \text{ or}$$
$$P2 = (M / U - V) \times 100$$

where P2 is the proportion of eligible persons who had one or more missed opportunities.

2.5 Classification by reasons for missed opportunities

Reasons for missed opportunities were classified as (1) failure to administer vaccines simultaneously; (2) false contraindications to immunization; (3) negative health worker attitudes; (4) logistical problems; and (5) patient or family refusal. The importance of each reason was measured, first, as the overall prevalence of missed opportunities due to the specific reason and, second, as the relative proportion of all the reasons given for missed opportunities. The first measurement is the overall magnitude of the reason-specific missed opportunity and, thereby, the potential gain in coverage that could be achieved if that specific missed opportunity were eliminated. The second measurement is the relative importance of the reason compared with all other reasons given for missed opportunities and is useful for prioritizing interventions to reduce missed opportunities.

3. TYPES OF STUDIES

Seventy-nine studies on missed opportunities were identified from 45 countries. Studies were conducted in each of the six WHO regions (Table 1). Worldwide, nearly one-quarter of all countries completed at least one study. Fifty-nine studies (75%) were conducted in developing countries; 20 studies (25%) were conducted in industrialized countries. Of the 79 missed opportunities studies, 52 (66%) were health service-based studies, 18 (23%) were population-based studies, and nine were intervention trials (Table 2).

Table 1. Studies of missed opportunities for immunization in developing countries and industrialized countries, by WHO Region.

WHO Region	Developing countries		Industrialized countries		Total	
	No. countries	No. studies	No. countries	No. studies	No. countries	No. studies
Africa	15	19	-	-	15	19
Americas	12	15	1	14	13	29
E. Mediterranean	6	11	-	-	6	11
Europe	1	3	2	5	3	8
South-East Asia	6	10	-	-	6	10
Western Pacific	1	1	1	1	2	2
Global total	41	59	4	20	45	79

Table 2. Studies of missed opportunities for immunization in developing countries and industrialized countries, by type of study.

Type of study	No. in developing countries	No. in industrialized countries	Total	
			No.	(%)
Health service-based	40	12	52	(66%)
Population-based	13	5	18	(23%)
Intervention trial	6	3	9	(11%)
Total	59	20	79	(100%)

3.1 Population-based observational surveys

Of the 79 studies reviewed, 18 (23%) were observational surveys that selected the study subjects by using a population-based approach (Annex 1). Thirteen population-based studies were conducted in 12 developing countries. Twelve of the 13 studies used EPI cluster sampling; one studied a village cohort. The EPI 30-cluster survey examines data on the home-based immunization card or child health record, specifically, the date of birth and the dates of immunization. EPI 30-cluster surveys in the Central African Republic (CAR), Guinea, and Mozambique also assessed opportunities missed during health service visits, as the dates of these visits were recorded on the child health card (11, 14-16). A total of more than 43,000 children and 22,000 women were studied in population-based surveys in developing countries.

Five population-based studies were conducted in 2 industrialized countries. Four studies used nonrandom samples of convenience; one used a random sample. Four studies were based on health records; one was based on parental interviews. In total, more than 1000 children were studied in industrialized countries.

3.2 Health service-based observational surveys

Of the 79 studies that were reviewed, 52 (66%) were health service-based observational surveys (Annex 2). Study subjects were selected from persons contacting health services: in 49 surveys the study subjects were outpatients; in three surveys the study subjects were inpatients.

Forty health service-based missed opportunity studies were conducted in 35 developing countries. Studies were conducted in all six WHO regions. The number of health facilities included in each survey differed considerably: 14 surveys (35%) included fewer than 5 health facilities; 15 (38%) included 5-19 facilities, and 11 (28%) assessed 20 or more health facilities. Of the 40 studies, 33 used the EPI exit interview protocol, 4 used record reviews, and 3 used hospital patient interviews. In total, more than 44,000 children and 52,000 women were studied at more than 500 health facilities in developing countries.

Twelve health service-based studies were conducted in three industrialized countries located in three WHO regions. Two studies used exit interviews and 10 used record reviews. A total of more than 7000 children were studied at some 80 health facilities in industrialized countries.

Most developing countries assessed missed opportunities by using the EPI protocol. Parents and patients in the EPI target group were interviewed as they exited a health service and were queried about their child's or their own immunization history and the reason for the health visit. An interviewer determined the missed opportunity for immunization by using the reason for the health visit and the national policy on contraindications to immunization. Immunization history was obtained from immunization cards; when these were not available, information was based on parental or patient recall. Immunization cards were available for most of the children: a median of 84% (range: 48%-100%) of the children enrolled had their cards. Cards were less frequently available for women, except for those attending antenatal clinics.

In countries where immunization records were kept in health care facilities, information was obtained from a retrospective review of medical charts or immunization registers. The health service-based method does not provide information on the magnitude of missed opportunities in the community unless the use of health services is high and a representative sample of all the health facilities in a community is surveyed. In general, however, this method is useful for measuring

the magnitude of missed opportunities at the health facility and for identifying their causes.

3.3 Intervention trials

Of the 79 missed opportunity studies reviewed, 9 (11%) were intervention trials (Annex 3). Eight trials used a health service-based approach to select study subjects; one used a population-based approach. Only one intervention trial was a controlled trial; the others used historical controls.

Six intervention trials were conducted in developing countries; three trials were conducted in industrialized countries. The effect of an intervention was determined by measuring the change in the prevalence of missed opportunities or the change in immunization coverage before and after the intervention. Information on these outcomes was collected through interviews with the target group or health care provider, or through reviews of medical charts.

4. PREVALENCE OF MISSED OPPORTUNITIES

4.1 Global

The 70 observational surveys from 44 countries were evaluated to determine the magnitude of missed opportunities for immunization (Annex 1-2). A median of 32% (range: 0%-99%) of the children and women of childbearing age who were surveyed had missed opportunities for immunization. In 69 surveys, opportunities to immunize were missed. The only survey that failed to find missed opportunities was an exit interview survey in Zimbabwe, where the policy of vaccinating at every health contact was being successfully implemented for children (39-40).

If opportunities to immunize had been taken in the specific populations and at the specific health services studied, immunization coverage would have increased by a median of 32%. Of children and women who were eligible for immunization at the health visit, a median of 67% (range: 0%-100%) were not immunized. That is, a given health service contact was 67% inefficient in taking opportunities to immunize eligible children and women.

4.2 Developing versus industrialized countries

Missed opportunities for immunizations were identified as an important problem both for developing and industrialized countries. Fifty-three observational studies were conducted among children in developing countries and 18 among children in industrialized countries (Table 2).

Studies included in this review showed that missed opportunities occurred more often among children in developing countries (median: 41%, range: 0%-99%) than in industrialized countries (median: 15%, range: 3%-55%). However, it is difficult to compare the findings from these

two groups of countries since 14 (82%) of the 17 industrialized country studies were conducted in one country (USA), whereas no more than 3 studies were conducted in any one developing country. Moreover, lists of contraindications tend to be longer in industrialized countries than in developing countries. Since the formula we used to calculate missed opportunities excludes children with contraindications (based on national policy), this might lead to a lower prevalence of missed opportunities in industrialized countries.

4.3 Rural versus urban areas

Only three studies in developing countries examined rural and urban differences (Table 3). No global trend emerged from these studies; however, it is clear that on a local level studying rural and urban differences identified high-risk populations, and this information would help in planning future immunization activities. In Zimbabwe, missed opportunities were 1.3 times higher for women in urban areas (39-40). In Colombia, missed opportunities for children were 1.8 times higher in rural areas (42). In the Central African Republic, missed opportunities for children were more frequent in urban areas, but for women missed opportunities were more frequent in rural areas (11).

Table 3. Prevalence of missed opportunities in rural and urban areas.

<u>Country</u>	<u>Reference</u>	<u>Study group</u>	<u>Prevalence of missed opportunities (%)</u>	
			<u>Rural</u>	<u>Urban</u>
CAR	11	12-23 months	28	37
		women	16	10
Colombia	42	0-23 months	60	34
Zimbabwe	39,40	3-23 months	0	0
		women	48	60

4.4 Preventive versus curative health services

Ten surveys in 10 developing countries compared the prevalence of missed opportunities during preventive services with the prevalence during curative or other health services (Table 4). Some of these countries had national policies to immunize in the curative services, others did not. Overall, opportunities for immunization were more likely to be missed in curative services than in preventive services. These surveys showed that many persons had visited health services at times when they were eligible for immunization and could have been

immunized if immunizations were offered. In 2 surveys, in the Central African Republic and in Mexico, missed opportunities were reported to occur more often during immunization services than during other health services, indicating a problem with the routine immunization delivery system (11, 47).

Routine screening in health facilities was found to be important in ensuring that eligible persons were immunized during visits for services other than immunization. For example, in surveys conducted in the Cameroon and Venezuela, persons who attended curative services missed opportunities only when there was no routine screening to determine their immunization status (32, 52). A study in Sudan demonstrated the importance of using screening at curative services (59-60). "Never immunized" children were identified at curative services but were less likely to be seen at preventive services.

Table 4. Prevalence of missed opportunities in preventive and curative health services.

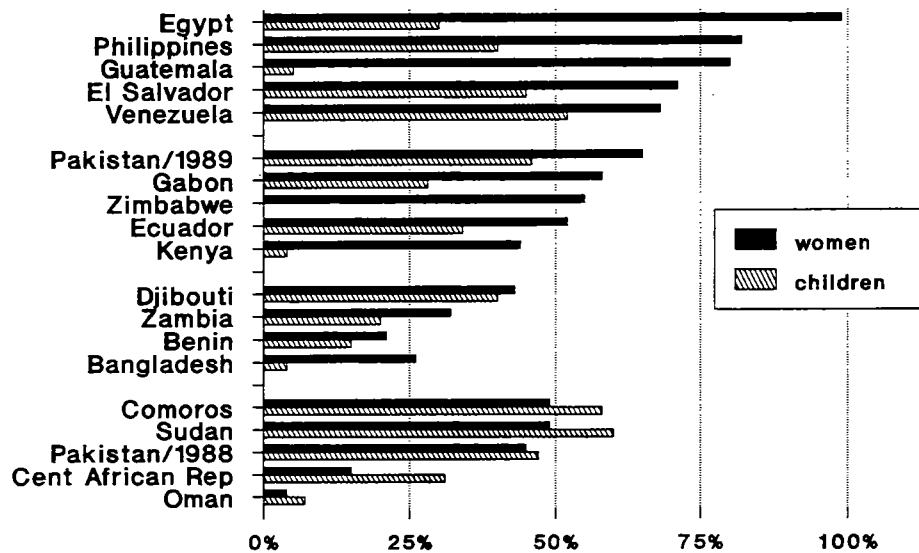
Country	Reference	Study group	Prevalence of missed opportunities (%)	
			Preventive	Curative
Cameroon	32	12-23 months	40	63
CAR		12-23 months	25	6
Comoros	33	0-23 months	33	91
		women	42	95
Ethiopia	34-35	0-23 months	30	44
Gabon	13	0-23 months	20	37
		women	54	63
Guinea	14	12-23 months	5	14
Mexico	47	0-59 months	54	40
Mozambique	14-16	12-23 months	2	60
Puerto Rico	18	2-59 months	16	27
Venezuela	52	0-23 months	48	56
		women	58	60
All countries:				
Median [range]				
Children			30 [2-54]	44 [14-91]
Women			54 [42-58]	60 [60-95]

An alternative use for a missed opportunities survey is to provide information on what improvements in immunization coverage could be expected by extending the number of days that immunizations are routinely offered. Studies were conducted for this purpose in Burundi and Gabon. In Gabon, for children and women, a 2- to 3-fold increase in missed opportunities was found on the days when immunizations were not scheduled (13). In Burundi, missed opportunities for children were lowest in facilities that immunized at every health contact (15%), compared with facilities that immunized every day but not at every contact (21%), or facilities that immunized fewer than four days per week (30%) (31).

4.5 Women versus children

Of the 59 surveys of children in developing countries, 19 also surveyed women of childbearing age (Figure 3). In 14 of these studies, women were found to have many times more missed opportunities than children. Only 5 studies found the prevalence of missed opportunities to be lower for women than for children. These data indicate that coverage of women of childbearing age with tetanus toxoid could be improved greatly by taking advantage of contacts with health services to immunize women.

Figure 3. Prevalence of missed opportunities among women 15-44 years and children 0-23 months, 19 studies.



4.6 Children of different ages

Surveys in seven developing countries compared missed opportunities between younger children (usually 0-11 months of age) and older children (Table 5). Opportunities for immunization were slightly more likely (1.1 to 1.4 times) to be missed for infants compared with children 0-59 months of age. These data may reflect the relatively small proportion of children age 12-59 months in developing countries who remain incompletely immunized.

In contrast, a study in the United States found that opportunities for immunization were 1.6 to 2.8 times more likely to be missed for children 13 months to 6 years of age compared with infants (77-79). The primary reason for the increase in missed opportunities for older preschool-aged children compared with infants was that the fourth dose of DPT and a single dose of a vaccine against hemophilus influenzae type b infection had not been given (Centers for Disease Control, unpublished data).

Table 5. Prevalence of missed opportunities in younger children compared all children, 8 studies in developing countries and 3 studies in an industrialized country.

Country	Reference	Prevalence of missed opportunities (%)			
		in younger children (months)		in all children (months)	
Colombia	42	75	(0-11)	52	(0-23)
Peru	51	57	(0-11)	48	(12-23)
Mexico	47	55	(0-11)	40	(0-59)
Paraguay	50	55	(0-11)	51	(0-59)
Venezuela	52	52	(0-11)	68	(0-23)
Djibouti	53	46	(0-8)	40	(0-35)
Egypt	54	45	(0-8)	30	(0-36)
Ethiopia	34-35	45	(0-11)	36	(12-23)
All developing countries					
Median [Range]		54	[45-75]	46	[30-68]
USA (ER)	78	14	(0-13)	23	(14-59)
USA (OPD)	77	26 +	(0-12)	73 +	(13-71)
USA (HCF)	79	0.34-1.94 ++		0.54-1.72 ++	

Notes:

ER - hospital emergency department.

HCF - outpatient health care facility.

OPD - hospital outpatient department.

+ - calculated as % missed opportunities for visits.

++ - calculated as missed opportunities/child/year.

4.7 Vaccine-specific missed opportunities

Missed opportunities were measured for specific vaccines in 13 surveys in 13 countries; ten (77%) were from the Region of the Americas (Table 6). Although there were considerable differences among countries, surveys conducted in Bolivia, Colombia, Ecuador, Mexico, Nicaragua, Nigeria, and Puerto Rico demonstrated that an opportunity to immunize with measles vaccine or BCG was missed more often than an opportunity to immunize with DPT or OPV (17-18, 41-43, 47-49). This difference may relate to the fact that these vaccines are given only once. Compared with DPT and OPV, it is more likely that one child or only a few children will require immunization with BCG or measles vaccine. Although it is the policy in most countries that health workers should open a vaccine vial even for one child, fear of wastage of vaccine has been reported frequently as a reason for this missed opportunity (see section 7.6).

Table 6. Prevalence of missed opportunities, by antigen.

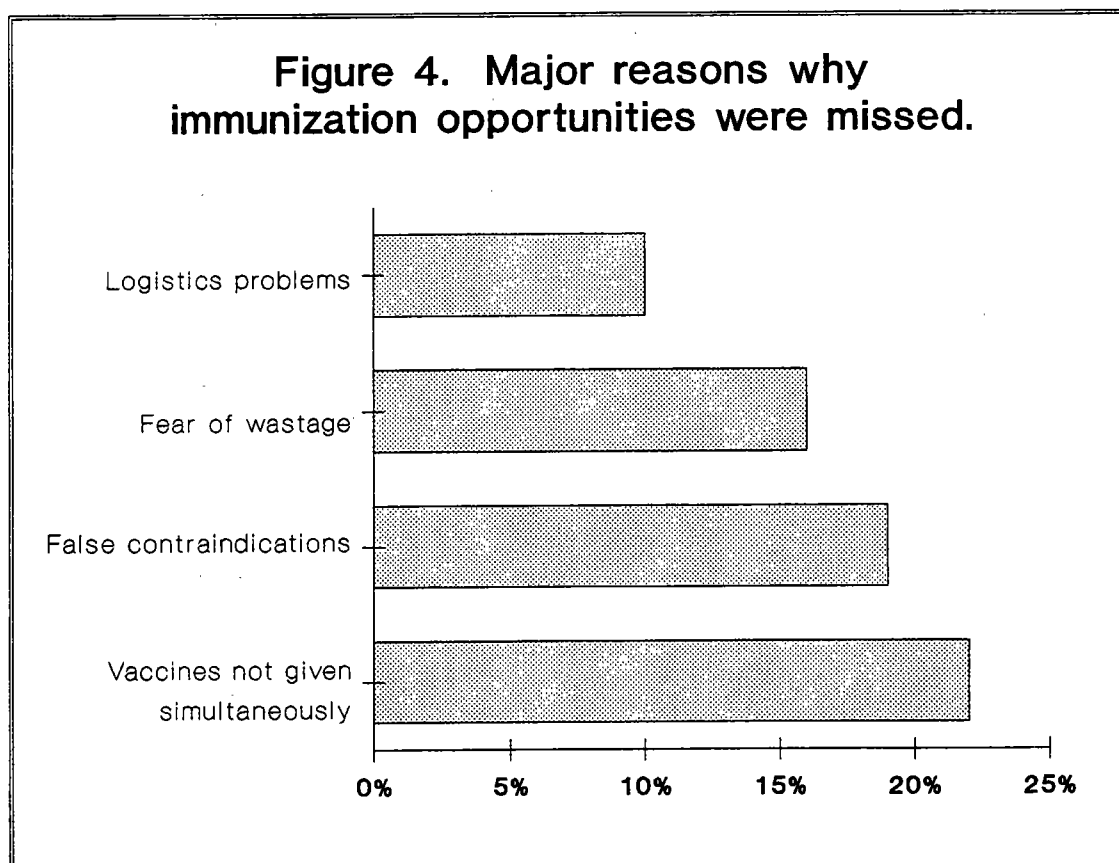
Country	Reference	Percentage of immunizations needed but not administered			
		BCG	DPT	OPV	Measles
Bolivia	41	35	28	25	52
Colombia	42	86	64	59	74
Ecuador	43	29	30	33	58
Guatemala	44	NA	48	47	20
Honduras	45-46	68	36	31	49
Mexico	47	83	80	74	84
Nicaragua	48-49	65	69	54	74
Nigeria	17	8	10	11	19
Peru	51	NA	48	47	36
Puerto Rico	18	NA	42	42	68
UK	92	NA	27*	37	20
Venezuela	52	8	42	32	30
Zambia	38	18	76	84	72
ALL COUNTRIES					
Median		35	42	42	52
[Range]		[8-86]	[10-80]	[11-84]	[19-84]

* Includes persons with true contraindications.

5. REASONS FOR MISSED OPPORTUNITIES

In general, the broad categories of reasons why immunizations were not given during a health visit were similar for developing and industrialized countries, although the relative importance of each reason within the broad categories differed. Developing and industrialized countries reported problems with inefficient scheduling of immunization services and long waiting times (93-94). Vaccine shortage was reported as a problem in some developing countries but not in industrialized countries. In developing countries, the fear that health workers have about wasting vaccines if they opened a multidose vaccine vial for one child was identified as an important reason for missed opportunities. In the surveys on missed opportunities that were reviewed, parental refusal to immunize children was a minor reason for missed opportunities; however, in industrialized countries, it may be more of a problem (97-99). Similarly, false contraindications may be more of a problem in industrialized countries, particularly in the United States, in part because of legal concerns (95, 97, 99, 100-104).

Reasons for missed opportunities were classified into 5 categories; details of this analysis are reported below and summarized in Figure 4.



5.1 Failure to administer immunizations simultaneously

Failure to administer immunizations simultaneously was one of the major reasons given in eight surveys where this was specifically assessed. In these surveys, a median of 22% (range: 2%-38%) of persons missed opportunities because immunizations were not administered simultaneously. This reason accounted for a median of 26% (range: 25%-81%) of all reasons given for missed opportunities. These measurements may be underestimates because many surveys classified failure to administer vaccine simultaneously as a logistical problem.

5.2 False contraindications

Twenty-seven surveys assessed the role of false contraindications for immunizations and 24 (89%) identified this as a problem. In these surveys, a median of 19% (range: 6%-65%) of persons missed an opportunity because of false contraindications to immunization. This reason accounted for a median of 28% (range: 6%-74%) of all reasons given for missed opportunities.

5.3 Negative health worker attitudes

Negative attitudes of health workers, including fear of wasting vaccines, and not offering, thinking about, or screening for immunization were assessed in 11 surveys and all found it to be one of the major reasons for missed opportunities. In these surveys, a median of 16% (0.5%-26%) of persons missed opportunities because of negative health worker attitudes. This reason accounted for a median of 35% (range: 1%-61%) of all reasons given for missed opportunities.

5.4 Logistical problems

Logistical problems with immunization delivery (e.g., vaccine shortage, poor clinic organization and inefficient clinic scheduling) were assessed in 11 surveys. This reason was found to be important in all 11 surveys. The prevalence of missed opportunities for children and women due to logistical problems was a median of 10% (range: 1%-24%). This reason accounted for a median of 15% (range: 1%-40%) of all reasons given for missed opportunities.

5.5 Parental refusal

In nine surveys, the refusal of immunizations by patients or their families was assessed. In general, lack of parental acceptance of immunization was not an important reason for missed opportunities. Missed opportunities due to patient or parental refusals occurred in a median of 3% (range: 2%-11%) of persons and accounted for a median of 6% (range: 5%-14%) of all the reasons given for missed opportunities.

6. STRATEGIES TO ELIMINATE MISSED OPPORTUNITIES FOR IMMUNIZATION

6.1 Strategies tested in intervention trials

Nine intervention trials were conducted in 8 countries (Annex 3). Following implementation of one or more interventions, each of the 9 trials demonstrated a reduction in missed opportunities or an increase in immunization coverage, although only 3 studies showed statistically significant changes. Of the 9 trials, missed opportunities were reduced by 8% to 69% and immunization coverage was increased by 10% to 145%.

The only trial designed to determine whether the observed change in missed opportunities was due specifically to an intervention was a controlled trial conducted in Venezuela in 1989 (86). Nine clinics were included: in six clinics, letters and posters that explained true contraindications to immunization were distributed; in three of these clinics, health records of children in need of immunizations were marked with a special stamp; in three control clinics no interventions were used. Surveys on missed opportunities conducted before and one month after these interventions found statistically significant declines in the prevalence of missed opportunities at all 9 clinics. These results may represent a "Hawthorne effect," in which persons respond to being studied, or reflect exposure of persons in the control clinics to an unplanned extra intervention, the distribution of immunization buttons.

A study in El Salvador demonstrated significant reductions in missed opportunities for children (69%), women of childbearing age (14%), and pregnant women (44%) after the institution of multiple interventions, specifically: (1) providing preintervention survey results to health care providers whose clinics were surveyed; (2) emphasizing the issue of false contraindications during in-service training; (3) stressing the role of health workers as future health facility directors; and (4) notifying health workers about plans to conduct a repeat survey to measure the progress toward reducing missed opportunities.

A third trial that demonstrated a statistically significant reduction in missed opportunities was conducted in the United States, in the State of Georgia during 1987-1990 (87). Interventions included annual reviews of missed opportunities and immunization coverage; an award system to motivate health workers; and the provision of immunization services in federal nutrition assistance programs serving public clinics. These interventions led to an 85% increase in immunization coverage in public clinics and an 80% decrease in the prevalence of missed opportunities.

The remaining trials implemented a variety of interventions. In Colombia, health workers and parents were notified about the need to assess immunizations at every health care visit and missed opportunities

were reduced by 37% (42). In Djibouti, interventions included: offering immunizations every day; opening multidose vials of vaccine, even for one child; and screening all women and children who visited the health facility (53, 88). In Nigeria, one clinic introduced an express lane for immunization services, so that children no longer had to wait to be seen by a physician before getting immunized (84). In Sudan, an intervention introduced at curative clinics was screening and immunization either before or after physician consultation (89-90). In Fife, United Kingdom, general physicians were sent letters encouraging them to administer measles vaccine and coverage increased by 27% (91). In Manchester, United Kingdom, children admitted to a hospital pediatric ward were screened for immunization status and immunized if eligible (92).

6.2 Zimbabwe EPI experience

In 1987, a survey of missed opportunities conducted in two clinics in Zimbabwe found no missed opportunities for children 3-23 months of age (39-40). The Zimbabwe EPI actively promotes a policy of immunizing eligible persons at every contact in a health facility. They have developed an effective strategy for reducing missed opportunities in pediatric clinics. A nurse screens every ill child for immunization status and vaccinates all eligible children, even before the physician consultation. The cost of this strategy (based on the time health personnel spent in implementation) is reported as US\$ 0.02-0.04 per patient per day in clinics providing integrated services.

6.3 Intervention trials in progress

A controlled intervention trial currently under way in Togo will assess immunization coverage levels before and after the institution of a policy to immunize at every health facility contact (105). The study will also assess the total cost of this intervention, including the cost of vaccine wastage. Results from this trial should be available in 1993.

Another trial began in fall 1991 in a pediatric outpatient department in Rochester, USA (106). Children are assigned randomly to an intervention group or control group. Medical charts of children in the intervention group are marked, indicating that the child should be screened for immunization status at every visit; charts of children in the control group are not marked. The occurrence of missed opportunities will be compared for children in the two groups.

7. CONCLUSIONS AND RECOMMENDATIONS

A number of potentially effective strategies to reduce missed opportunities have been recommended by the GAG and tested in studies conducted in both developing and industrialized countries. Immunization programme managers should identify specific reasons for missed opportunities occurring in their programmes, select the most appropriate strategy, and monitor the effect of the strategy in reducing missed opportunities.

Based on the reasons identified in this global review of missed opportunities, the following recommendations are relevant for immunization programmes in all countries:

7.1 Use missed opportunities surveys routinely

Studies reported in this review have shown that the assessment of missed opportunities is a useful managerial tool, as well as a method suited to health services research.

EPI has developed a module for EPI mid-level managers to assess the causes of missed opportunities and to determine effective strategies for their elimination (118). The module, entitled "Identify Missed Opportunities" is the seventh module in the EPI mid-level training series.* The module is currently available in English; French and Russian versions will become available during 1993. Each year thousands of district level health workers worldwide receive training using the mid-level modules. The module has been prepared to serve district and provincial staff as a supervisory and evaluation tool.

Further studies at the national, district, and provincial levels may provide guidance for policy decisions. Studies may be planned to determine the specific age groups, geographic areas, and immunization services in which immunizations are most often missed. The importance of specific reasons for missed opportunities should be assessed, including gaps in health worker knowledge, attitudes, and practice.

7.2 Screen and immunize at every contact

This review found that missed opportunities for immunization affect both children and women of childbearing age and occur in both preventive and curative health services. Many persons eligible for immunization have contact with health services and could be immunized if vaccines were offered. Furthermore, the increased risk for children of contracting measles in health facilities has been documented both in developing and industrialized countries, underscoring the importance of

* Identify Missed Opportunities (WHO/EPI/MLM/91.7) is available from the Expanded Programme on Immunization, WHO, 1211 Geneva 27, Switzerland.

protecting them through immunization at every health service contact (107-108). Routine screening for immunization status should occur for all children and women of childbearing age who visit health services for any reason. The timing for screening in the patient flow process should be tailored to the health service. Intervention trials indicated that screening and immunizing before or after the physician consultation were equally effective. Ideally, eligible persons should be immunized immediately, but at a minimum, they should be referred for immunization. National immunization policy may need to be revised or fully enforced to focus on screening for immunization at every health contact.

To facilitate screening for immunization status at every health visit, immunization cards should be used for both children and women of childbearing age. Mothers should be reminded to bring their child's and their own immunization or health record to every contact with a health service.

7.3 Administer vaccines simultaneously

In this review, failure to administer immunizations simultaneously was found to be a major cause of missed opportunities. Administering vaccines simultaneously, when indicated, should be the rule. The vaccines currently used in the EPI (BCG, OPV, DPT and measles vaccine) can all be given simultaneously (109). These vaccines may also be given at the same visit when yellow fever vaccine and hepatitis B vaccine are administered. A number of studies demonstrate that simultaneous administration of EPI vaccines is safe and effective (109). In-service training and periodic supervisory visits should assist in reducing this type of missed opportunity.

Whether opportunities for simultaneous immunization are being taken can be readily assessed in immunization coverage surveys that use COSAS, the EPI software for analysis using a personal computer.* WHO estimates that more than 100 coverage surveys are analyzed each year with COSAS.

7.4 Emphasize true contraindications

False contraindications to immunization were found to be a major cause of missed opportunities. To avoid this type of missed opportunity, health workers should have in-service training and be reminded periodically through posters and supervisory visits about true contraindications to immunizations. The fact that EPI vaccines have few true contraindications should be emphasized (110). Countries should review and, if necessary, redefine their policy on contraindications.

* COSAS software is available in English and French from the Expanded Programme on Immunization, WHO, 1211 Geneva 27, Switzerland.

In general, children who have illnesses that do not require hospitalization should be immunized. Therefore, children suffering from malnutrition, low-grade fever, mild respiratory infection, diarrhea, and other minor illnesses should be immunized. The immunization status of hospitalized children should be assessed and they should receive appropriate immunizations before discharge. If possible, they should be immunized against measles on admission because of the high risk of hospital-acquired measles (110).

True contraindications include not giving a second or third dose of DPT vaccine to a child who has had a severe adverse reaction to the previous dose (110). In this situation, the pertussis component should be omitted and diphtheria and tetanus immunizations given.

Unimmunized persons with clinical (symptomatic) AIDS in countries where the EPI target diseases remain serious risks should not receive BCG, but should receive the other vaccines. In general, live vaccines are not given to immunocompromised persons, but in developing countries, the risk of measles and poliomyelitis in unimmunized infants is high and the risk from these vaccines, even in the presence of symptomatic AIDS, seems to be low (111-112).

A precaution should be taken when administering OPV to a child who has diarrhea. OPV should be given, but to ensure full protection, a dose given to a child with diarrhea should not be counted as part of the series. The child should be given another dose at the first available opportunity (110).

It should be emphasized that immunizations are just as effective in sick children as in healthy ones, and there is no increased risk of side effects in sick children (110). However, one small study recently published in the United States reported that measles seroconversion rates after a dose of measles-mumps-rubella (MMR) vaccine were 79% for children with a mild upper respiratory infection, compared with 99% among well children (113). This study should not have any impact on global policy to immunize sick children for the following reasons. First, the study is not consistent with previously reported studies from developing countries (114-115). Second, the study findings are unusual, since a lower seroconversion rate was found only for measles and not for mumps or rubella (116). Finally, it should be emphasized that the measles immunity conferred by giving a single dose (79%) of measles vaccine is much higher than not giving any vaccine (0%).

Concerns about immunizing women during early pregnancy have not been justified. There is no convincing evidence of risk to the fetus from immunizing pregnant women with tetanus toxoid (117).

7.5 Provide immunization updates

In-service education is essential and immunization updates should be provided to all health workers, curative and preventive, at least annually. Update sessions can readily be included in meetings of medical and nursing associations. In countries where the private sector provides immunizations, guidelines and training should be made available. Including the EPI training materials in medical, paramedical, public health, and nursing school curricula may be an effective method of positively influencing the attitudes of health workers early in their training.

7.6 Reduce vaccine wastage by choosing correct size vials

Today most vaccines for developing countries are purchased in 20-dose vials. Current EPI policy is to open a multidose vial, even for one child or woman. At the end of an immunization session, all open vaccine vials, whether used or only partly used, must be discarded. Partly used vials contain wasted vaccine. EPI training materials teach that wastage rates of 25% are to be expected. Nevertheless, this review found that health worker concerns about wasting vaccines if they open a multidose vial for one child was an important reason for missed opportunities.

In 1991 these findings led to a series of studies of vaccine wastage in different countries. These studies revealed markedly higher wastage rates than expected. When immunization sessions were held once a week or more frequently, wastage rates were as high as 40%-60% for OPV and DPT, and 80%-90% for BCG. In this situation, changing from a 20-dose vial to a 10-dose vial reduced vaccine wastage by as much as 20%-40%.

In the absence of other information, programmes should choose to use 10-dose vials for DPT, OPV, and tetanus toxoid, and 5-dose vials for measles when immunization sessions are held more frequently than once a week. In most cases the savings from the reduced wastage will be greater than any increase in purchasing and delivery cost per dose from use of smaller vials. The availability of a smaller multidose vial may encourage health workers to open a multidose vaccine vial, even for one child.

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Annex 1
POPULATION-BASED SURVEYS ON MISSED OPPORTUNITIES

DEVELOPING COUNTRIES		Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for Age (%) ^a	Missed Opportunity (%) ^b
	AFR	10	Cameroon	Yaounde	1982	30-cluster sample	12-23 months	213	31	20 ^{**}	
	AFR	11	Central African Republic (CAR)	Capital, Urban, Rural	1990	30-cluster sample stratified by area	12-23 months 15-45 years	642 656	34 40	31 [*] 15 [*]	
	AFR	12	Gambia	National	1990	30-cluster sample	15-28 months	241	66 (measles vaccine)	12 ^{**}	
	AFR	13	Gabon	Rural	1989	Complete village cohort	0-23 months 15-44 years/program	77 70	64 33	36 ^{**} 87 ^{**}	
	AFR	14	Guinea	Conakry	1986	Modified cluster sample	12-23 months	377	19	19 [*]	
	AFR	14-16	Mozambique	6 cities & 1 rural area	1987	30-cluster sample in each area	12-23 months	640	62	8 [*]	
	AFR	17	Nigeria	National	1991	30-cluster sample in each of 22 states	12-23 months	4,565	56	4-8 [*]	
	AMR	18	Puerto Rico	2 neighborhoods	1990	Modified cluster sample	2-59 months	77	27	22 [*]	
	EMR	19	Iran	54 provinces	1986	Cluster sample	12-23 months	11,517	56	4 [*]	
	EMR	20	Iran	12 provinces	1986	Cluster sample	12-23 months	21,064	70	3 ^{**}	
	EUR	21	Turkey	National	1986	30-cluster sample	12-23 months	2,519	57	56 (% of eligible)	
	SEAR	22	Bhutan	National	1988	30-cluster sample	12-23 months	180	62 (measles vaccine)	7 [*]	
	SEAR	23	Nepal	3 Districts (Nuwakot, Palpa, Surkhet)	1985	Cluster sample	12-23 months	80	46 (measles vaccine)	54	

Annex 1 (Continued)

POPULATION-BASED SURVEYS ON MISSED OPPORTUNITIES

INDUSTRIALIZED COUNTRIES									
Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for Age*	Misled Opportunity (%)#
24	AMR	USA	Dade County, Florida	1986	Nonrandom selected sampleⓐ	16-59 months	31	57++ (measles vaccine at 2 yrs)	22* (adjusted)
25	AMR	USA	Louisiana	1987	Random sample	25-36 months	555	90 (at 24 months)	0*
26	AMR	USA	Dallas County, Texas and New York City, New York	1990	Nonrandom selected sampleⓐ	6-59 months	209	90++ (measles vaccine at 24 months)	9**
27-28	EUR	United Kingdom	Bristol	1990	Nonrandom selected sampleⓑ	2 years	201	87++ (pertussis vaccine)	12*
29	EUR	United Kingdom	Manchester	1984	Nonrandom selected sampleⓑ	Births between 1/7/82-3/9/82	61	28++ (pertussis vaccine)	55*

+ - up-to-date for age for all vaccines unless otherwise indicated, vaccine history from record or parent's memory, vaccine coverage measured for the study population.
 ++ - vaccine coverage is not measured directly from study population, missed opportunity is adjusted based on coverage.
 * - missed opportunities obtained from record or health care provider.
 ** - missed opportunities reported by parent.
 # - percent of study population who missed one or more opportunities for immunization, missed opportunity is adjusted if coverage not directly measured for study population.
 ⓐ - unvaccinated children with measles.
 ⓑ - unvaccinated children against pertussis.

HEALTH SERVICE-BASED SURVEYS ON MISSED OPPORTUNITIES

ANNEX 2

DEVELOPING COUNTRIES									
Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for Age (%)†	Missed Opportunity (%)**
30	AFR	Benin	Cotonou	1988	Exit interview of outpatients in 7 clinics	0-23 months 15-49 years	189 283	85 78	15 21
31	AFR	Burundi	2 provinces	1989	Exit interview of outpatients in 12 clinics	0-23 months	282	77	23
32	AFR	Cameroon	Yaounde	1981	Exit interview of random sample of parents in 11 public and private urban clinics	2-35 months	1,010	37-80	40-80
33	AFR	Comoros	Grande Comore & 2 other areas	1986	Exit interview of outpatients in 5 clinics	0-23 months 15-44 years	26 149	36 51	56 49
34-35	AFR	Ethiopia	Addis Ababa	1987	Exit interview of outpatients and record review in clinic or home in 8 out of 35 health facilities	0-23 months	882	59	41
13	AFR	Gabon	National	1989	Exit interview of outpatients in 36 health facilities	0-23 months 15-44 years/pregnant women	664 808	63-80 37-45	28 58
36	AFR	Ivory Coast	Abidjan	1987	Exit interview of outpatients in 6 health facilities	0-35 months	523	51	49
37	AFR	Kenya	5 districts	1988	Exit interview of outpatients in 2 clinics	0-23 months pregnant women	23 18	87 56	4 44
18	AFR	Mozambique	Moatize District	1987	Observations in 1 clinic at a health center post	Child	65	65	31
38	AFR	Zambia	3 provinces	1988	Exit interview of outpatients in 25 health facilities	0-23 months 15-45 years	639 842	80 68	20 32
39-40	AFR	Zimbabwe	Harare/Bulawayo	1987	Exit interview of outpatients in 2 clinics	3-23 months CSA women	147 189	98-100 40-52	0 48-80
41	AMR	Bolivia	4 major urban centers	1989	Exit interview in 2 health centers	<4 years	572	NA	32 (data missing/doses needed)
42	AMR	Colombia	Bogota/Sucre	1989	Exit interview of outpatients in 35 clinics	0-23 months	981	52	45

HEALTH SERVICE-BASED SURVEYS ON MISSED OPPORTUNITIES

Box 2 (Developing Countries, Continued)

Reference	Region	Country	Location	Study Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for age (%)	Missed Opportunity (%)**
43	AMR	Ecuador	5 provinces	1989	Exit interview of outpatients in 65 health facilities	<2 years CBA women	1,007 893	34 48	34 (doses missed/doses needed) 52
44	AMR	Guatemala	7 regions	1990	Exit interview of outpatients in 24 health facilities	0-23 months CBA women	1,326 2,797	49 20	5 80
45-46	AMR	Honduras	National	1989	Exit interview of outpatients in 60 health facilities	0-23 months	507	56	46 (doses missed/doses needed)
47	AMR	Mexico	7 cities in 3 regions	1989	Exit interview of outpatients in 26 clinics	<5 years	812	80	40
48	AMR	Puerto Rico	4 of 8 regions	1990	Exit interview of outpatients in 25 clinics	2-59 months	273	35	52
48-49	AMR	Nicaragua	12 health areas	1987	Exit interview in multiple health posts with an active EPI and interview at home	1-35 months	3,276	66	34
50	AMR	Paraguay	8 health areas	1990	Exit interview of outpatients in 40 health facilities	<5 years	1,290	49	51
51	AMR	Peru	7 of 28 health departments	1990	Exit interview of outpatients in 31 health facilities	2-23 months	1,350	52	48
52	AMR	Venezuela		1989	Exit interview of outpatients in 9 clinics	0-23 months 15-45 years	836 921	48 NA	52 98
53	EMR	Djibouti	Capital/Tadjourah	1989	Exit interview of outpatients in 2 health facilities	0-35 months 15-45 years	134 107	55 57	40 43
54	EMR	Egypt	Rural area	1988	Exit interview of outpatients in 1 health facility	0-36 months 15-45 years	78 78	67 1	30 99
55	EMR	Oman	Capital	1989	Exit interview of outpatients in 12 health facilities	0-23 months 12-50 years	197 287	84 95	7 4
6-57	EMR	Pakistan	4 provinces	1983	Exit interview of outpatients in 26 health facilities	3-23 months	4,420	34	69

HEALTH SERVICE-BASED SURVEYS ON MISSED OPPORTUNITIES

next 2 (Developing Countries, Continued)

Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for Age (%)†	Missed Opportunity (%)
56	EMR	Pakistan	3 provinces	1988	Exit interview of outpatients in 16 health facilities	0-23 months 15-45 years	717 717	53 54	47 45
56	EMR	Pakistan	5 provinces	1988	Exit interview of outpatients in 8 health facilities	0-23 months 15-45 years	353 353	43 34	48 85
59-60	EMR	Sudan	Khartoum	1988	Exit interview of outpatients in 11 health facilities	<1 year CSA women	254 167	72 64	80 49
21	EUR	Turkey	6 provinces	1988	Exit interview of outpatients in health facilities	Child	186	51	49
21	EUR	Turkey	Istanbul	1988	Interview hospitalized patients at 1 hospital	<1 year	53	40	80
61	SEAR	Bangladesh	Dhaka	1989	Prospective interview of outpatients attending a diarrheal treatment center	0-23 months 15-45 years	17,372 44,317	90 74	4* 28*
62	SEAR	Bhutan	Thimphu	1985	Consecutive retrospective record review	9-47 months	113	30 (measles vaccine)	41*
63	SEAR	Bhutan	Thimphu	1988	Consecutive retrospective record review	9-47 months	319	54 (measles vaccine)	11*
22, 63-64	SEAR	Bhutan	Gaylephing Dumphu Lhuntshi	1988	Retrospective review of immunization register	0-23 months	358	43 (measles vaccine)	4*
65	SEAR	India	Vellore	1983-1984	Record review of charts	<6 years (74% of study subjects)	448	27	49*
66	SEAR	Indonesia	6 provinces	1988	Exit interview of outpatients in clinics	2-14 months	104	24§ (unweighted)	76
67-68	SEAR	Nepal	4 regions	1989	Exit interview of outpatients in 7 health facilities	Children and women	139	68	31
69-70	SEAR	Thailand	Bangkok, Nan, Buriram, Satun	1987	Exit interview of outpatients in 4 health facilities	<1 year	63	36	80
71	WPR	Philippines	Cebu City	1989	Exit interview of outpatients in 1 large health facility	0-23 months 15-45 years	35 57	57 16	40 82

HEALTH SERVICE-BASED SURVEYS ON MISSED OPPORTUNITIES

Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date for Age (%)†	Missed Opportunity (%)‡
72	AMR	USA	Tennessee (2 counties)	1973	Sample of all births in 1969 using HD clinics	2 years	427	61 (measles vaccine)	15*
73	AMR	USA	Baltimore, Maryland	1980	Medical record review of inpatients	2-24 months	102	84++	19*
74	AMR	USA	Georgia (1 health district)	1980-1987	Immunization record review in 14 health departments	21-23 months	NA	41	15*
75	AMR	USA	Virginia	1987	Random sample of computerized records from 40 public clinics	24-36 months	2,300	42	32*
76	AMR	USA	Dade County, Florida	1987	Nonrandom sample of clinic records in 5 public clinics	0-4 years	61	89++ (measles vaccine)	5*
77	AMR	USA	Los Angeles, California	1988	Retrospective record review	15 months-4 years	254	63 (measles vaccine)	30*
78	AMR	USA	Chicago, Illinois	1989	Prospective survey of outpatients seen in 2 hospital emergency rooms	6 months-5 years	763	52 (measles vaccine)	28*
79	AMR	USA	Rochester, New York	1990	All active patients in computer information system in 1 facility	36 months-6 years	515	73	82*
80	AMR	USA	Rochester, New York	1990-1991	Random sample of medical charts of outpatients in health facilities	9-36 months	921	NA	0.59-1.04++
81	AMR	USA	Atlanta, Georgia	1991	Exit interview of outpatients and medical record review in 18 public clinics	2-40 months	411	82	18
82	EUR	Russia	Moscow (4 districts)	1992	Review of records	0-3 years	1,668	72 (DPT)	3
83	WPR	Australia	Newcastle	1988	Mail of telephone interview of postnatal inpatients from one facility	NA	22	88	8

- up-to-date for age for all vaccines unless otherwise indicated, vaccine history from record or parent's memory, vaccine coverage measured for the study population.
 † - vaccine coverage is not measured directly from study population, missed opportunity is adjusted based on coverage.
 ‡ - missed opportunities obtained from record or health care provider.
 * - missed opportunities reported by parent.
 †† - percent of study population who missed one or more opportunities for immunization, missed opportunity is adjusted if coverage not directly measured for study population.
 ‡‡ - unvaccinated children with measles.
 ††† - unvaccinated children against pertussis.
 †††† - rate of missed opportunities (number of missed opportunities/persons/year), not limited to persons not up-to-date for age.
 A - not available

INTERVENTION TRIALS ON MISSED OPPORTUNITIES

INDUSTRIALIZED COUNTRIES										
Reference	Region	Country	Location	Survey Year	Survey Method	Age Group	Study Population (Number)	Fully Immunized or Up-to-Date+	Missed Opportunity++	Change
							Before	Before(%)	After(%)	Change
90	AMR	USA	Georgia	1987-1990	Historical control trial, record review in all public clinics.	21-23 months	7,970	34	15	+85%
							16,080	63	3	-80%
91	EUR	United Kingdom	Fife	1982 and 1984	Historical control trial, telephone interview of parents, one intervention tested.	2 years	91	63	36	+27%**
77	EUR	United Kingdom	Manchester	1989-1990	Historical control, prospective survey of inpatients, one intervention tested.	5 months-6 years	296	81	95	+17%**

Before - before the intervention(s).

After - after the intervention (s).

+ - up-to-date for age for all vaccines unless otherwise indicated, vaccine history from record or parent's memory, vaccine coverage measured for the study population.

++ - percentage of one or more missed opportunities.

* - statistically significant change in missed opportunities or immunization coverage.